Convective Drug Transport in the Spinal Cord

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Challenge/Problem: Challenges remain in predicting drug transport for methods such as convection-enhanced delivery. Models need to account for the orientation of embedded white matter fibers which influence convective drug transport through the interstitial space.

Progress: We have developed magnetic resonance (MR)-based finite element models of the spinal cord that predict the regional distribution of albumin following infusion into the white matter dorsal column. We have also obtained high resolution MR and diffusion tensor images of the rat spinal cord.

Approach: 3D interstitial transport models of the spinal cord will be developed and validated with regional infusion experiments. The fiber orientation data embedded in diffusion tensor imaging (DTI) data will be used to assign interstitial transport directions in a finite element model of the spinal cord. In vivo distribution studies using MR imaging will track distribution of Gd-albumin into the spinal cord following peripheral nerve infusion.

Current/Near Term Products: Final products include a 3D finite element interstitial transport model of the rat spinal cord, experimental tools to measure hydraulic conductivity, Gd-albumin distribution measurements of peripheral nerve infusion, and DTI scans of excised spinal cord.

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Future Plans: Following validation of this approach in the spinal cord. We plan to develop DTI-based transport models of different regions of the brain, e.g. brainstem and corpus callosum.

Keywords: DTI, porous media, interstitial transport, convection-enhanced delivery, FEM